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AN OPTIMIZATION OF TIG WELDING (SS304) PARAMETERS USING DESTRUCTIVE AND NONDESTRUCTIVE TESTING METHOD

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ABSTRACT

The study has been done by conducting various tests on the TIG welded material, by using the Destructive and Non-destructive Testing Methods. The quality of the welded material has been analysed. The results of the analysis have revealed that the Stainless steel used to weld the joints of grade SS304 using TIG welding with the external factor of application of varying current has exhibited high tensile strength and relatively high hardness on keeping the other parameters such as voltage, speed, gas flow rate, current type, filler diameter constant. Thus, it is concluded that the sample 1 has the better weld quality compared to other samples. The current range used to weld the sample1 is 189-192 Amps. According to these test results, sample1 has a suitable current range for TIG welding using stainless steel of grade 304.

KEYWORDS: Current, Destructive Testing, Non-Destructive Testing, Stainless Steel & TIG Welding

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Original Article

INTRODUCTION

TIG welding is otherwise called Gas Tungsten Arc Welding. The procedure of TIG welding utilises a non-consumable tungsten anode to create weld. The weld is shielded from oxidation by the atmosphere by an inert gas protecting. TIG welding takes a shot at the same guideline of arc welding. In a TIG welding process, a high exceptional bend is created between tungsten anode and work piece. In this welding generally workpiece is associated with the positive terminal and cathode is associated with negative terminal. This arc produces heat vitality which is additionally used to join metal plate by fusion welding.

(Huang et al. 2019), investigated that a standout amongst the most outstanding methods is to utilise an enacted transition in TIG welding process. This epic variation of the TIG procedure is known as A-TIG welding, which utilises a flimsy layer of actuated transition on the outside of the joint. The essential advantage of utilising transition is to lessen the warmth vitality required for TIG infiltration. Kuang-Hung et al. (2011), directed the investigation on execution of enacted TIG process in austenitic tempered steel welds. (Nguyen, Nguyen, and Huang 2018)To acquire astounding welds and stable weld circular segment, the A-TIG process requires huge width cathodes to help a given dimension of the weld current. TIG welding with SiO2 and M0O3 transitions accomplishes an expansion in weld profundity and a lessening in globule width, individually. The SiO2 motion can encourage root pass joint infiltration, however the Al2O3 transition prompted a disintegration in the entrance contrasted with the traditional TIG process for Type 316L tempered steel welds. (Muncaster 1991) A-TIG welding can expand the joint infiltration and weld profundity to-width proportion, altogether lessening the rakish mutilation of the

well-implied. (Kusano and Watanabe 2002)Since the enacted TIG welding can build the circular segment voltage, the measure of warmth input per unit length in a weld is likewise expanded and consequently the delta-ferrite content in weld metal will be expanded. The expansion of oxide transition does not fundamentally influence the hardness of Type 316L hardened steel actuated TIG weld metal. (Tseng and Chen 2012) Communicated that MoO3 transition helped TIG welding strategy can create a huge improvement in power thickness of warmth source and weld viewpoint proportion, bringing about low rakish contortion and remaining feelings of anxiety. The MoO3 motion helped TIG welding related with a quick cooling rate of the welds, in this way displaying higher ferrite content in austenitic treated steel 316L weld metals amid the hardening in the wake of welding.

Figure 1: SS304 TIG Welded Plates

MATERIALS AND METHOD

Materials Used

Grade 304 of Stainless steel is the most flexible and the most generally utilised of every stainless steel. Its compound arrangement, mechanical properties, weld capacity and non-erosion/oxidation obstruction give the best all-round execution stainless steel at generally minimal effort. It likewise has incredible low temperature properties and reacts well to solidifying by virus working.

Test Specimen

In this work, three different test specimens of diameter 200*100 with thickness of 4 mm, were welded as listed in Table.

Table 1

Test Sample	Materials	Current Range
TS1	SS304	189-192 Amps
TS2	SS304	195-204 Amps
TS3	SS304	230-240 Amps

Tensile Test

Tensile testing, otherwise called strain testing, is a basic materials science and engineering test in which an example is exposed to a controlled pressure until disappointment. Properties that are legitimately estimated by means of a tensile test are extreme tensile quality, breaking quality, most extreme stretching and decrease in the territory. From these estimations the accompanying properties can likewise be resolved:

Young's, Poisson's proportion, quality, Strain-solidifying attributes.

Bend Test

The primary reason for the Bend testing is to decide the flexibility, bend quality, break quality and protection from the crack of the example for example the attributes used to decide if a material will flop under strain and are particularly significant in any development procedure including pliable materials.

Hardness Test

Hardness tests are utilised in mechanical engineering o decide the hardness of a material to disfigurement. A few such tests exist, wherein the analysed material is indented until an impression is shaped; these tests can be performed on a naturally visible or infinitesimal scale.

Impact Test

Impact test decides the measure of vitality consumed by a material amid crack. This consumed vitality is a proportion of a given material's durability and goes about as an instrument to contemplate temperature-subordinate weak malleable progress. It is to decide if the material is weak or pliable in nature.

Microstructure Test

Microstructure Analysis to Evaluate Materials. Amid Microstructure Analysis of metals and alloys, a Microscopic Examination is directed to contemplate the micro structural highlights of the material under amplification.

Non-Destructive Test (LPT)

LPT depends on slender activity, where surface strain liquid low enters into perfect and dry surface-breaking discontinuities. Penetrant might be connected to the test part by plunging, splashing, or brushing. After sufficient infiltration time has been permitted, the overabundance penetrant is evacuated, and an engineer is connected. The designer draws penetrant out of the imperfection so that an undetectable sign winds up noticeable to the reviewer. Examination is performed under bright or white light, contingent upon the kind of colour utilised - fluorescent or no fluorescent (noticeable).

RESULTS AND DISCUSSIONS

Tensile Test

Table 2

Test Method: ASME SEC IX-2014	TS1	TS2	TS3
TENSILE STRENGTH	600.32 MPa	359.49 MPa	564.08 MPa

Tensile Survey for 3 Samples

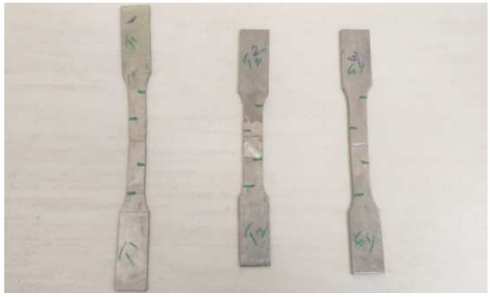


Figure 2: Tensile Test on Workpiece SS304

From the above test result it shows that the test sample one has high tensile strength and the other two is significantly different, so the current used in Test sample 1 (TS1) is the best weld.

Bend Test

Test Method: ASME SEC IX-2014

Table 3

Sample Details	TS1	TS2	TS3
Bending Load (KN)	4.21	4.14	3.84

Bend Survey for 3 Samples

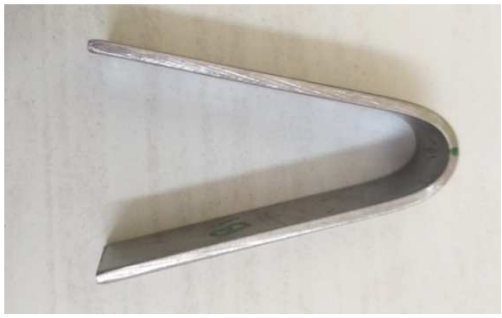


Figure 3: Bend Test on Workpiece SS304

From the above test result it shows that the test sample one has the best bend strength and the other two is low compared to the Test sample 1, so the current used in Test sample 1 (TS1) is the best weld.

Hardness Test

Table 4: Hardness Survey for Sample 1

Weld Zone	Base	HAZ	Weld
	183 HV	180 HV	181 HV
	178 HV	180 HV	182 HV
	190 HV	187 HV	188 HV
Average	**183.66 HV**	**182.33 HV**	**183.66 HV**

Table 5: Hardness Survey for Sample 2

Weld Zone	Base	HAZ	Weld
	166 HV	168 HV	170 HV
	179 HV	177 HV	178 HV
	187 HV	182 HV	185 HV
Average	**177.33 HV**	**175.66 HV**	**177.66 HV**

Table 6: Hardness Survey for Sample 3

Weld Zone	Base	HAZ	Weld
	186 HV	190 HV	183 HV
	201 HV	203 HV	205 HV
	210 HV	212 HV	213 HV
Average	**199 HV**	**201.66 HV**	**200.33 HV**

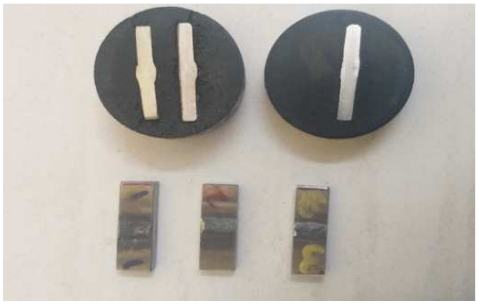


Figure 4: Hardness Test on Workpiece SS304

From the above test result it shows that the test sample 3 has the high Hardness ratio compared to the other two samples, but the Test sample 1 has the high strength in other test and offers stable results, so the current used in Test sample 1 (TS1) is the best weld.

Impact Test

Table 6: Impact Survey for 3 Samples

Test Method: ASME SEC IX-2014	TS1	TS2	TS3
IMPACT VALUES(JOULES)	32	8	10

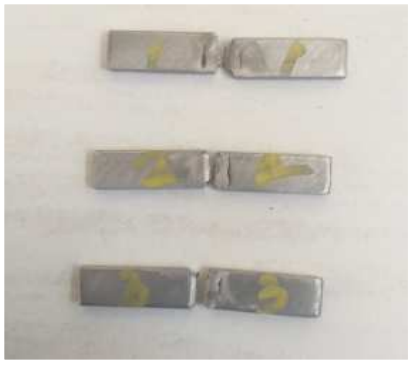


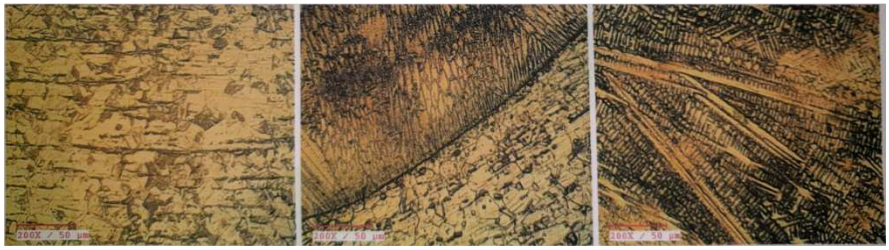
Figure 5: Impact Test on Workpiece SS304

From the above test result it shows that the test sample one has high impact strength and the other two is significantly different, so the current used in Test sample 1 (TS1) is the best weld.

Microstructure Test

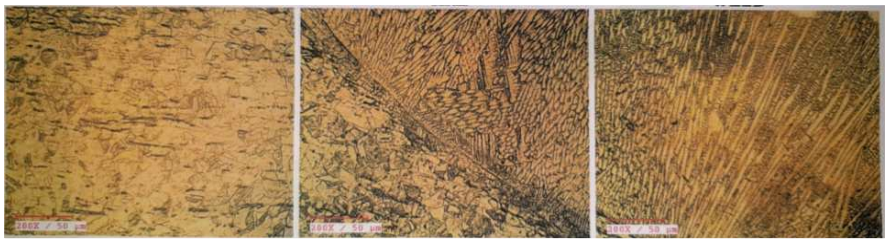
This micro structural test is done under 200x magnification. Etchant used – Glyceregia with 45 seconds.

- **BASE:** The Structure show twinned austenite grains throughout the matrix.
- **HAZ:** The Structure shows complete fusion between weld and base material
- **WELD:** The Structure shows interdendritic chromium-carbide precipitation in an alpha solid solution.



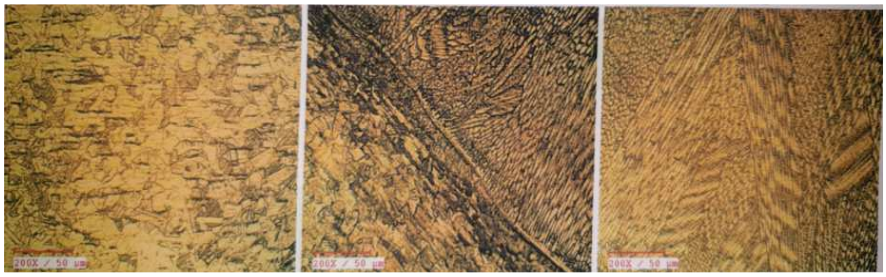
Base Weld Zone Heat Affected Zone Welded Zone

Figure 6: Micrograph of Test Sample 1 (200X / 50µm)



Mean Weld Zone Heat Affected Zone Welded Zone

Figure 7: Micrograph of Test Sample 2 (200X / 50µm)



Mean Weld Zone Heat Affected Zone Welded Zone

Figure 8: Micrograph of Test Sample 3 (200X / 50µm)

Non-Destructive Test (LPT)

- Test Sample 1(TS1): No Recordable open surface indication observed
- Test Sample 2(TS2): No Recordable open surface indication observed
- Test Sample 2(TS3): No Recordable open surface indication observed.

From the above test result it shows that all the 3 Test samples has no recordable surface penetration thus all the 3 sample are good weld quality.

CONCLUSIONS

This research work proved that the weld joints of SS304 with a varying current by keeping all other parameters constant. The weld soundness determined by using destructive and non-destructive testing methods. According to these test results, sample 1 is a suitable current range for TIG welding using stainless steel grade of 304.

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